THE EFFECTS OF MYOFASCIAL DECOMPRESSION AND NEURODYNAMIC SLIDING ON HAMSTRING TIGHTNESS IN DIVISION I TRACK ATHLETES

By

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Abstract: The purpose of this study is to examine the effects of myofascial decompression and neurodynamic sliding technique on hamstring tightness in Division I track athletes. Twenty one athletes (mean ± SD: age= 20.24 ± 1.136 yrs; height= 1.70 ± .082 m; mass 64.42 ± 10.689 kg) complaining of hamstring tightness with less than 80° in the Active Knee Extension test were randomly assigned to three groups consisting of 7 subjects each [Myofascial Decompression (MFD), Neurodynamic Sliding (NDS), and Control (CON)] for five minutes of treatment. Hamstring length (ROM) electromyographic analysis (EMG), rate of force development (RFD), and muscle torque (TOR) were assessed prior to, immediately post, and 24 hours after the intervention. Subjects also completed patient-reported outcome instruments, the Lower Extremity Functional Scale (LEFS) and Disablement in the Physically Active Scale (DPAS) at all time points. There were no significant differences between the three interventions with respect to ROM, EMG, RFD, and TOR immediately post and 24 hours after treatment. Improvements in ROM after MFD and NDS were observed although not significant. In conclusion, MFD and NDS can be used as methods to improve ROM without impacting performance or strength.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

The hamstring muscles comprise of the biceps femoris muscle, long head and short head, laterally and the semimembraneous muscle and semitendinosus muscle medially.[1] There are architectural differences between the hamstring muscles, including variation in muscle weight, pennation angle, muscle volume, physiological cross-sectional area, and muscle fiber length.[1] All of these muscles work together for the main function of hip extension and knee flexion.[2]The main movements of hip extension and knee flexion play an important role in daily activities such as controlled movement of the trunk, walking, running, and jumping along with maintaining balance and posture in standing position.[3] There are two components of the running gait cycle; the stance phase and swing phase.[4] The stance phase begins with footstrike, followed by midstance, and then take-off.[4] The swing phase occurs when the lower extremity swings through the air from take-off to footstrike. It includes the follow through, forward swing, and foot descent.[4] During the swing phase, the hamstrings are lengthening as the lower leg extends[4] causing an eccentric contraction[2] in order to decelerate knee extension.[5] Then the hip extends in the second half of the swing to continue into the first half of the stance phase.[5] The swing phase occurs 45% to 90% of the sprinting gait cycle.[7] Due to it being a multi-joint muscle, the hamstrings are more likely to strain during the late swing phase of sprinting[1,4,6,7] because of greater excursion and high concentration of fast-twitch muscle fibers.[8]

Hamstring strains are the most common injury in sports.[1,9,10] In track and field, hamstring strain injuries account for 26% of all injuries.[11] Most hamstring injuries occur in sprinting events.[7] The long head of the biceps femoris is the most injured muscle in hamstring strains.[1] Predisposing factors to hamstring injury are low hamstring to quadricep ratio or muscle imbalances[5,9,10,11,12,13,14],hamstring inflexibility[3,5,7,9,10,11,12,13,14],inadequate warm-up[8,9,10,13,14] ,history of previous injury[8,9,11,13,14] ,neural tension[7,8,9,12,14] ,fatigue[8,9,10,11] ,and poor lumbar posture and core stability.[3,7,10,12]

Symptoms of pain, decreased range of motion, and increased resting muscle tone can be produced when the sciatic nerve is overstretched.[15] The nerve can be overstretched after a hamstring injury[15] and cause adhesions on the nerve and abnormal mechanosensitivity[16] contributing to perceived hamstring tightness.[17] Decreases in nerve mobility result in altered normal nerve movement in adjacent soft tissue. [15] This principle, known as adverse mechanical tension,[15] states that the nervous system should be stretched and contracted properly to maintain normal muscle tension and ensure range of motion.[3] Originally known as mobilisation of the nervous system[18], it is now known as its contemporary term of neurodynamics. Neurodynamics describes the dynamic interaction of the biomechanical, physiological, and morphological functions of the nervous system.[14,17,19,20] This approach works on the healthy mechanics of the nervous system and enables pain-free posture and movement[18] by applying force to nerve structures through posture and multi-joint movements.[3] One form of neurodynamics is the neurodynamic sliding technique. It can decrease neural mechanosensitivity and be used for management of hamstring flexibility.[9]

Another way hamstring flexibility can be restricted is from the fascia surrounding the muscle. Fascia is connective tissue that surrounds muscles, nerves, blood vessels, and connects structures of the body. Fascia can become restricted due to injury, disease, inactivity, or inflammation.[21] Restrictions can decrease flexibility, strength, endurance, and motor coordination.[21] A traditional Chinese medicine technique known as myofascial decompression or cupping can be used to treat musculoskeletal pain.[22,23, 24,25,26,27] The treatment dates back to 1550 BC in Egypt. There is evidence of it being used in China 28AD.[26,27] The treatment involves plastic cups and the application of a vacuum to a localized area of the skin. The vacuum is created by a manual hand-pump. [26,27,28] The cups range in diameter from 38 mm-50 mm.[29] Larger cups exert more stress compared to smaller cups on the fat and muscle layers. The high tensile stresses inside the cup is believed to cause a severe dilation of the capillaries, leading to rupture.[27] It is considered autohemotherapy since it causes local edema, ecchymosis, or minor bleeding from the capillary vessels.[27] The after-effects of cupping are erythema, edema, and ecchymosis in a characteristic circular pattern that may take several days to weeks to subside.[27,28] Traditional Chinese medicine believe that cupping is able to unblock and correct imbalances in the flow of *Qi* to restore health. [28] Based on this traditional Chinese medicine theory, cupping should have a positive effect on hamstring tightness.

There have been studies performed to investigate the effects of myofascial decompression and neurodynamic sliding on flexibility and range of motion. To our knowledge, there are no current studies to investigate the effects of these techniques on strength-based performance measurements, such as rate of force development (RFD) and torque (TOR). According to Palmer, strength-based performance measurements can be used to distinguishing between athletes and non-athletes. The ability to demonstrate maximal strength capacities could possibly be an important characteristic in power-related sports, such as track and field.[30] Looking into the effects of MFD and NSD on RFD and TOR on track and field athletes can provide us if these techniques has an impact on their performance. Since little is known about the immediate effects these techniques have on strength, it is necessary to examine if any short-term post-treatment strength parameter changes are noted after the application of these common techniques.

Therefore the purpose of this study was to compare the effects of myofascial decompression (MFD) and neurodynamic sliding technique (NDS) in track and field athletes with complaints of hamstring tightness. The study investigated the short-term effects of MFD and NDS based on hamstring range of motion (ROM), muscle activation as determined by electromyography (EMG), torque production (TOR), and rate of force development (RFD). Our hypothesis was that neurodynamic sliding will have a stronger influence in all clinical outcome variables, and myofascial decompression will only have an effect on ROM.

CHAPTER II

METHODOLOGY

Twenty one track and field student-athletes (20.24 ± 1.136 yrs; 1.70 ± .082 m; 64.42 ± 10.689 kg; 9 males; 12 females) participated in the study. This study was approved by the university's institutional review board for human subject's research, and was a registered clinical trial study. All participants signed and completed an informed consent document and health history questionnaire. Inclusion criteria was defined as must participate in the Sprints, Jumps, or Multi (heptathlon, pentathlon, or decathlon) groups, complain of hamstring tightness and/or injury in the last calendar year, and have less than 80° for Active Knee Extension test.[5,6,14,29,31] Additionally, participants were free of any of the contraindications of the cupping techniques, including unhealed wounds, active TB, leukemia, hemophilia, thrombocytopenia, fever, influenza, moderate/severe anemia, high blood pressure, cardiac conditions, and late stages of pregnancy. [32] Participants were excluded if they had a past history or current neurological disorders or orthopedic diseases[33], surgery of the lower extremity that involves an autograft on the tested leg, and past history of hamstring surgery.[1,8,17,21] Participants could not be rehabilitating a current hamstring injury[3], but were allowed to do maintenance rehab exercises. Participants were not allowed to do any form of myofascial therapy or neurodynamic techniques 1 week prior to study.[16]

Participants were randomized into three treatment groups; 1) myofascial decompression therapy (MFD), 2) neurodynamic sliding (NDS), and 3) control group (CON) (sham diathermy). There were 7 participants in each treatment group. Measurements were conducted pre/post intervention and again 24 hours after treatment. Measurements included hamstring length assessment using the Active Knee Extension ROM test, electromyographic (EMG) analysis of muscle activation, and strength measures consisting of rate of force development (RFD) and peak torque (TOR). Prior to testing, participants filled out a questionnaire with the subject#, group#, age, height, weight, and leg dominance. Subjects also completed patient-reported outcome assessments at the three time points of the study; the Disablement of the Physically Active Scale (DPAS) and the Lower Extremity Functional Scale (LEFS). Subjects completed the DPAS and LEFS as a baseline before intervention, immediately after, and 24 hours after intervention.

The Active Knee Extension (AKE) was used to measure ROM because it eliminates pelvic rotation compared to Straight Leg Raise.[33] Subjects were placed supine with both the hip and knee positioned at 90° of flexion and then asked to extend lower leg until point of limitation. Hip flexion was maintained with the use of box on the distal thigh and subject has to keep contact with board during extension. The non-tested leg was strapped to the table with a belt over the inferior thigh and over the anterior superior iliac spine by using a weight belt and two 25lb weight plates. A digital inclinometer (Digital Protractor Pro 360; Level Developments Ltd, Chicago, IL) was used to measure hamstring flexibility. Subjects were blinded to measurements and were tested three times with the average of the three measures recorded for analysis. All ROM measures were taken by the same examiner. Anatomical landmarks were identified marked on the medial joint line of the knee above medial tibial plateau and measured the distance from the medial joint line to medial malleolus to determine tibial lever arm length. The mark was placed on tibial crest for placement of digital inclinometer.[33]

Hamstring strength (TOR and RFD) were measured using an isokinetic dynamometer (Biodex3; Biodex Medical Systems, Shirley, New York). Participants were seated with 90° of coxofemoral flexion and the body was stabilized by several straps around the thigh, waist, and chest. The torque signal was sampled at 2000 samples/sec (MP100; BIOPAC Systems, Inc., Goleta, CA), converted to Nm, and smoothed using a 20 ms moving average. The linear slope coefficient of the rapidly increasing portion of the processed torque signal was used to assess RFD (Nm/s), and the maximal value of the signal was used for TOR (Nm).

Figure 1 Subject performing RFD, EMG, and TOR testing on the Biodex3.

Subjects were also instructed to grip the side handles to stabilize their upper body. The axis of rotation of the dynamometer was aligned with the center of the lateral epicondyle of the femur, and the lower leg was attached to the lever arm proximally 2 cm above lateral malleolus. Range of motion stops were set at 60° and 45°of full knee extension on the dynamometer. Subjects were asked to perform three maximum contractions of the knee flexors in the 60° and 45° positions. Subjects were allowed 60 seconds of rest between each contraction. [2,10,34]

Electromyography (EMG) (MP100; BIOPAC Systems, Inc., Goleta, CA) was used to measure muscle activation of the biceps femoris. Two surface electrodes (Ambu BlueSensor L; Ambu, Malaysia) were placed 2 cm apart on the muscle belly of biceps femoris in a bipolar arrangement 50% of the distance between the gluteal fold and popliteal fold with a ground electrode placed on the head of the fibula. Skin was prepped for placement of electrodes by shaving, abrading, and cleansing with alcohol. [21,35] The raw EMG signals were amplified by a gain of 1000, sampled at 2000 samples/s, bandpass filtered (cutoffs = 10-500Hz), and smoothed with a 20 ms Root-mean-square (RMS) moving window. The maximal value of the smoothed RMS signal was used as EMG amplitude (mV).

Subjects completed patient-rated outcome scales before and immediately after intervention, and at 24 hours post-testing, completed the DPAS[36] and the LEFS.[37] The DPAS is a 16-item generic patient-rated outcome measure designed for physically active individuals. The multidimensional scale contains questions related to impairment, functional limitations, disability, and quality of life and are scored on a Likert scale of 1-5. Higher scores on the DPAS indicate functional limitations and decreased wellbeing.[38]

The LEFS is a questionnaire containing 20 questions about a person's ability to perform everyday tasks. Scores range from 0-4 and represent 'extreme difficulty' or 'unable to perform activity' to 'no difficulty'. The maximum score is 80, with lower scores indicating a greater disability. The minimal detectable change on the LEFS is 9 scale points. The LEFS has a very high test-retest reliability (0.94).[38]

Neurodynamic Sliding

Subjects assigned to the neurodynamic sliding group (NDS) sat on the treatment table while performing cervical and thoracic flexion along with knee flexion and ankle plantar flexion. They then performed cervical and thoracic extension and knee extension with ankle in dorsiflexion (Figure 2). Subjects alternated the two active movements for 60 seconds repeated 5 times, with rest periods of 15 seconds between sets. A metronome was used to standardize the movements so that 15 full slides per minute were completed. [3,8,14,17]

Figure 2 Movements for Neurodynamic Sliding (NDS)

Myofascial Decompression

Subjects assigned to the myofascial decompression group (MFD) (AcuZone Premium Cupping Set; K.S. Choi Corp., Los Angeles, CA) were placed in a prone position and the cups placed along the fascial line. The fascial line starts medial to lateral and at the origin of the hamstring to the insertion of the gastrocnemius.[32] Large cups of 5.08cm in diameter were placed under the gluteal fold, and on the midbelly of the hamstring between the ischial tuberosity and the popliteal fossa. A 2.54cm diameter cup was placed on the popliteal space with one3.81cm diameter cup placed on the medial head of the gastrocnemius, and another placed on the musculotendinous junction of the gastrocnemius (Figure 3).[32] Air was removed from the cups so that the tissue was raised to the first line. subjects performed active quad sets and ankle dorsiflexion at 5 repetition each. Total treatment time lasted 5 minutes. Subjects assigned to the control group (CON) received a sham diathermy treatment (machine not turned on) for 5 minutes.

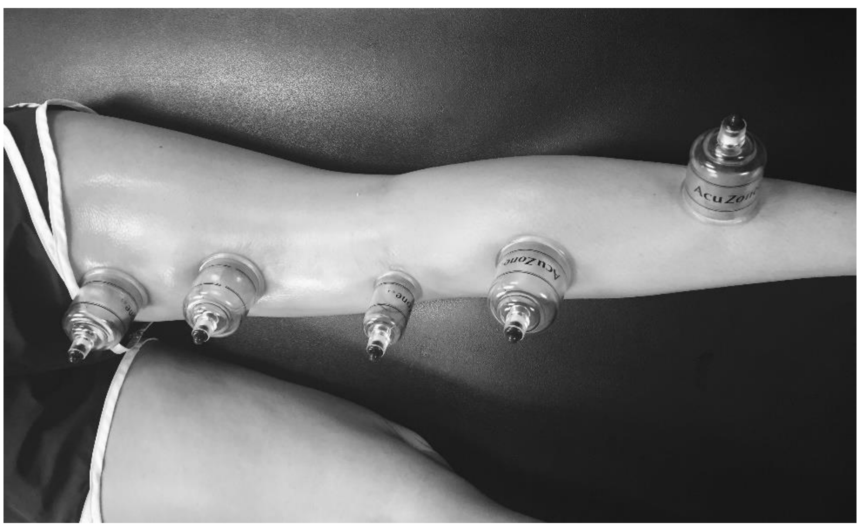

Figure 3 Displays the placement of the MFD cups

Statistical Analyses

2-way (time x group) mixed factorial ANOVAs were ran. The interaction terms in the results come from the 2-way models. Separate 1-way analysis of variance (ANOVA) tests were used to compare means for ROM; EMG amplitude, TOR and RFD data at 45° and 60°;

and the patient-rated outcome scales DPAS and LEFS among the three treatment conditions (MFD, NDS, CON). Repeated Measures were conducted to compare means for ROM, EMG amplitude, TOR, and RFD data at 45° and 60°; and the patient-rated outcome scales DPAS and LEFS among the three treatment conditions (MFD, NDS, CON). When appropriate, pairwise comparisons were evaluated using a Tukey's HSD post hoc analysis to determine between group differences. Statistical analyses were performed using SPSS software (version 23.0; IBM Corp, Armonk, NY). The α level was set at .05.

CHAPTER III

RESULTS

The study had twenty one track and field student-athletes (20.24 ± 1.136 yrs; 1.70 ± .082 m; 64.42 ± 10.689 kg; 9 males; 12 females). MFD group consisted of 1 male and 6 females (20.29 ± 1.11 yrs; 59.81 ± 11.6 kg; 1.67 ± .38 m). The NDS groups consisted 4 males and 3 females (20.57 ± 1.51 yrs; 67.65 ± 11.1 kg; 1.70 ± 0.09 m). The CON group had 4 males and 3 females (19.86 ± 0.69 yrs; 65.80 ± 9.16 kg; 1.73 ± 0.08 m). Means and standard deviations of the variables assessed are shown in Table 2. The data demonstrated improvement in range of motion in all groups post intervention and 24 hours after intervention except MFD; however these improvements were not significant. There was no significance among all of the variables throughout the different stages of the study. There were no differences in ROM between groups immediately post treatment [$F_{(2, 18)} = 1.610$; $^{p} = 0.23$], and also at 24 hours post intervention [$F_{(2, 18)} = 1.000$; $^{p} = 0.39$] (Figure 4).Patient-reported outcomes did not vary between treatment groups. Scores on the LEFS were not significantly different at immediately after [$F_{(2, 18)} = .610$; $^{p} = 0.55$] or 24 hours post intervention [$F_{(2, 18)} = .093$; $^{p} = 0.91$]. Likewise, results of the DPAS were not significant at either time points [$F_{(2, 18)} = .266$; $^{p} = 0.77$] and [$F_{(2, 18)} = .328$; $^{p} = 0.72$] respectively (Figure 5). Table 4 displays the means and standard deviations of the DPAS (Figure 6). The EMG amplitude values were 0.70%, 0.64%, and 0.74% of the MVIC for the MFD, NDS, and CON conditions immediately after intervention, respectively immediately. There were no significant changes between the groups post treatment on EMG amplitudes at 45° [$F_{(2,18)}$=.709; ^{p}=0.51] and 60° [$F_{(2.18)}$=1.042; ^{p}=.37]. There was no significant difference between the EMG values 24 hours post intervention at 45° [$F_{(2,18)}$=.798;^{p}=.47] and 60° [$F_{(2,18)}$=.550; ^{p}=.59]. TOR values showed no significant changes post intervention at 45° [$F_{(2,18)}$=.718; ^{p}=.50] and 60° [$F_{(2,18)}$=.531;^{p}=.60]. TOR values 24 after the intervention did not report any significance at 45° [$F_{(2,18)}$=.831; ^{p}=.45) and 60° [$F_{(2,18)}$=1.234;^{p}=.31]. RFD reported no significant changes post treatment at 45° [$F_{(2,18)}$=2.842; ^{p}=.09] and 60° [$F_{(2,18)}$=.920; ^{p}=.42]. There were no significant changes 24 hours post intervention for RFD at 45° [$F_{(2,18)}$=.885; ^{p}=.43] and 60° [$F_{(2,18)}$=.187; ^{p}=.83].

There was no time x group interaction observed for ROM [$F_{(4,36)}$= .859, ^{p}=.50], EMG at 45°[$F_{(4,36)}$= 1.186, ^{p}= .15], TOR at 45° [$F_{(4,36)}$= 2.141, ^{p}= .10], RFD at 45° [$F_{(4,36)}$= 1.026, ^{p}=.41], EMG at 60° [$F_{(4,36)}$= 1.077, ^{p}= .38], TOR at 60° [$F_{(4,36)}$= .948, ^{p}= .42], RFD at 60° [$F_{(4,36)}$= .138, ^{p}=.14], LEFS [$F_{(4,36)}$= .906, ^{p}= .47], and DPAS [$F_{(4,36)}$= .480, ^{p}= .66]. There was no main effect for time for ROM [$F_{(2,36)}$= 2.504, ^{p}=.10], EMG at 45°[$F_{(2,36)}$=1.845, ^{p}=.17], TOR at 45° [$F_{(2,36)}$=2.644, ^{p}=.09], RFD at 45° [$F_{(2,36)}$= .130, ^{p}=.88], EMG at 60° [$F_{(2,36)}$=.932, ^{p}= .40], TOR at 60° [$F_{(2,36)}$= 1.160, ^{p}= .31], RFD at 60° [$F_{(2,36)}$= .641, ^{p}= .53], and LEFS [$F_{(2,36)}$= 1.123, ^{p}= .34]. DPAS was the only main effect with significance [$F_{(2,36)}$= 5.134, ^{p}= .03].

		MFD	NDS	CON
Age		20.29 ± 1.11	20.57 ± 1.51	19.86 ± 0.69
Mass		59.81 ± 11.6	67.65 ± 11.1	65.80 ± 9.16
Height		1.67 ± .38	1.70 ± 0.09	1.73 ± 0.08
Dominant leg	**Right**	7	6	6
	Left	0	1	1
Gender	**Male**	1	4	4
	Female	6	3	3

Table 1 Demographics of the subjects in the study.

	EMG 45°	EMG 60°	TOR 45°	TOR 60°	RFD 45°	RFD 60°
MFD						
Pre	1.130 ±.448	1.067±.474	84.894±17.372	69.356±16.656	216.626±100.530	210.239±37.703
Post	1.104 ±.523	1.014±.382	77.129±22.173	69.404±20.027	196.144±66.243	211.857±74.508
24hr	1.206 ±.557	1.047±.454	78.940±22.587	70.239±26.209	254.177±83.431	268.490±97.659
NDS						
Pre	1.186 ±.619	1.041±.606	99.289±30.377	82.6563±26.389	334.906±172.882	394.473±200.064
Post	1.186 ±.754	1.079±.646	97.121±32.649	81.130±30.212	373.659±170.440	320.661±139.788
24hr	.917 ±.373	.880±.350	87.914±32.808	82.449±31.131	299.633±152.463	273.861±166.674
CON						
Pre	1.210±.418	1.267±.450	99.086±33.596	85.206±36.959	262.211±179.992	253.993±213.114
Post	.844 ±.318	.951±.399	92.313±40.346	84.517±34.230	235.539±175.458	245.480±213.960
24hr	.929 ±.504	1.146±.601	101.211±39.811	105.900±62.702	218.221±96.500	236.560±91.818

Table 2 Muscular output data (EMG, TOR, and RFD in the two positions for each study group

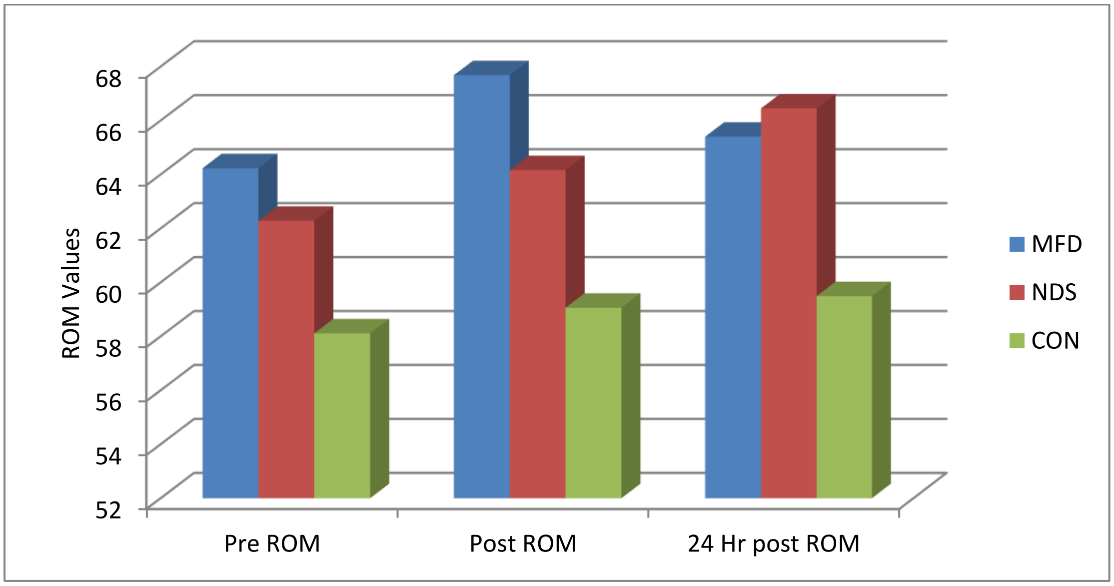

Figure 4 ROM before, immediately after, and 24 hours after receiving treatment.

		Mean	Std. Deviation
PreLEFS	MFD	78.71	1.98
	NDS	77.00	4.90
	CON	77.71	3.50
PLEFS	MFD	73.57	14.92
	NDS	78.14	3.24
	CON	78.14	2.61
P24LEFS	MFD	79.29	1.89
	NDS	78.86	2.61
	CON	78.86	1.86

Table 3 Mean and Standard Deviation for the Lower Extremity Functional Scale (LEFS) between the MFD, NDS, and CON groups. PLEFS means post intervention. P24LEFS means post intervention 24 hours.

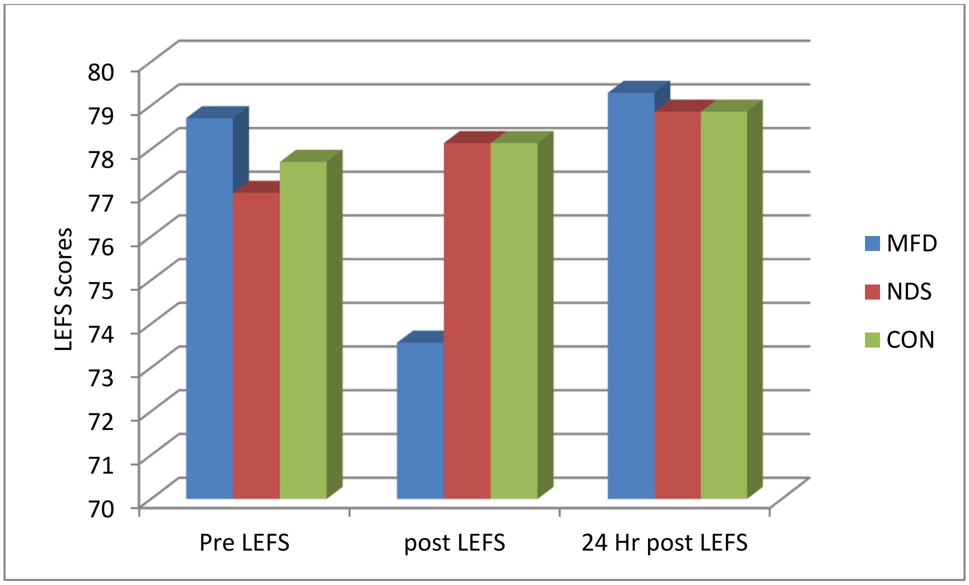

Figure 5 Compares the means of LEFS score between the MFD, NDS, and CON groups

		Mean	Std. Deviation
PreDPAS	MFD	5.43	6.13
	NDS	5.43	12.3
	CON	4.57	5.71
PDPAS	MFD	1.86	2.34
	NDS	2.71	5.31
	CON	3.86	6.77
P24DPAS	MFD	1.29	2.22
	NDS	2.71	5.06
	CON	2.86	4.22

Table 4 Means and Standard Deviations of Disablement of Physically Active Scale scores between MFD, NDS, and CON groups

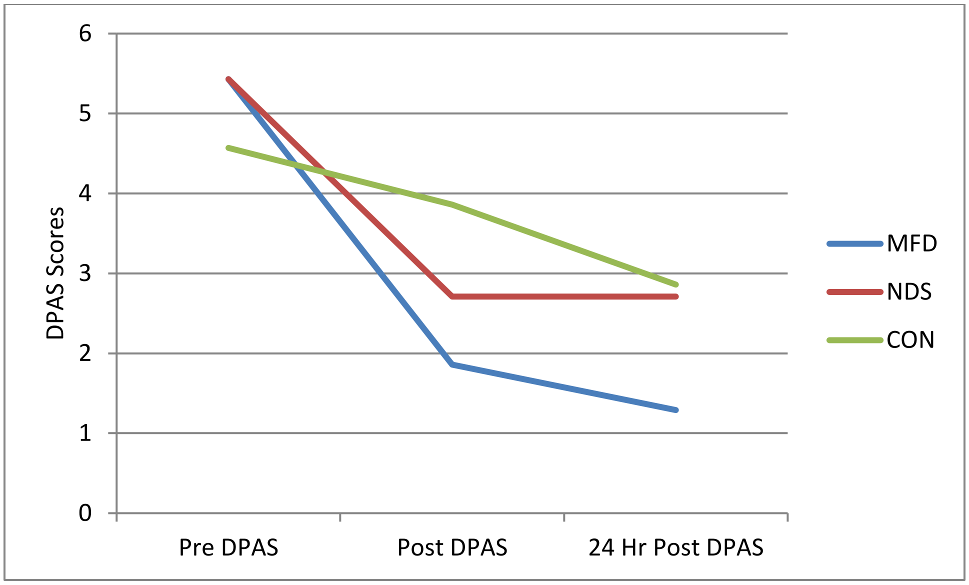

Figure 6 Changes in the DPAS values over the three time points of the study

	ROM	EMG 45°	TOR 45°	RFD 45°	EMG 60°	TOR 60°	RFD 60°	LEFS	DPAS
Main Effect for Time	.10	1.73	.09	.88	.40	.31	.53	.34	.03
Time x Group Interaction	.50	.15	.10	.41	.38	.42	.14	.47	.66

Table 5 2-way (time x group) mixed factorial ANOVA for ROM, EMG, TOR, RFD, LEFS, and DPAS

CHAPTER IV

DISCUSSION

This study investigated the effects of myofascial decompression (MFD) and neurodynamic sliding (NDS) on TOR, EMG, RFD, and ROM and patient-rated outcome measures using the LEFS and DPAS.

Overall, there was an increase of hamstring ROM for all intervention groups. For the MFD group, there was a 3.45° (5.42%) change from pre to post treatment, and 1.16° (1.87%) change after 24 hours. For the NDS group, there was a 1.189° increase in hamstring ROM from pre- to post intervention (a 3.16%) and a 4.17° (6.83%) increase in hamstring ROM at 24 hours after intervention when compared to pre-intervention. The control group had an increase of .95° (1.66%) initially and 1.38° (2.39%) increase in hamstring ROM 24 hours after intervention when compared to pre-intervention measurements. There was no significance between the groups in hamstring ROM. These findings support the research of Park[3] and Castellote-Caballero.[14] It shows that movement of the sciatic nerve together with the hamstring and compliance of the nerve, resulting in increased flexibility[3]. The participants could have greater results with the neurodynamic sliding technique if they completed the intervention three times within a week span similar to Castellote-Caballero[14] and Sharma et al[16]. Castellote-Caballero was able to show a significance between-group difference favoring neurodynamic sliding in order to increase hamstring flexibility. Sharma was able to prove that neurodynamic sliding were more effective when compared to static stretching. There is currently no research on the effects of myofascial decompression and its effects on hamstring ROM. Based on the information that we have collected from this study, there is no clinical significance on the improvement of hamstring ROM, but it did improve hamstring ROM initially when compared to pre-intervention. The lasting effects of MFD on hamstring flexibility did not appear to demonstrate positive change after 24 hours of treatment. There is no difference after 1 treatment using either MFD or NDS compared to no treatment CON in impacting hamstring flexibility (ROM), but there also was not a change (positive or negative) in strength after these techniques as well.

Based on current research findings, there has not been a study that has looked at the effects of myofascial decompression on EMG, peak torque, and rate of force development. A decrease in EMG amplitudes were observed at both 45° and 60° positions from pre-intervention to immediately then an increase in 24 hours after intervention. There were no significant differences, thus essentially no changes in EMG activity across the time points among the 3 conditions. The data shows that after a single treatment there were no observable changes (positive or negative) in terms of muscle activation after treatment. It was surprising there was no change in EMG with MFD since Arroyo-Morales et al demonstrated a significant decrease of vastus medialis EMG during 40 minutes of massage on the quadriceps while MacDonald et al performed 2 minutes of self-myofascial release with a foam roller without any change in EMG. [39] Our findings and these studies show that there could be a correlation between myofascial release or soft tissue work and the impact on muscle activation.

There has not been research on the effects of neurodynamic sliding on EMG, peak torque, and rate of force development for the lower extremity. There have been studies performed with Carpal Tunnel Syndrome subjects by having them perform nerve glides in the upper extremity and testing their grip strength. These studies were performed over a period of time and saw a significant difference with grip strength[19]. These studies show us that neurodynamics can make an improvement in strength over a period of time. Mendiguchia et al[2] completed a study on the effects of neuromuscular training on strength and sprinting mechanics. The neuromuscular training involves plyometric exercises, which improved eccentric torque about 15%. This supports the hypothesis if the subjects completed the neurodynamic slides for multiple sessions for a period of time, we may have seen consistent improvements on torque. This is something that should be investigated in future studies. Looking at the findings with EMG readings, we could have changed how we collected our data by having them perform an eccentric movement to mimic running. Higashihara et al[6] performed a study that looked at peak time of hamstring stretch and activation. Their findings showed that peak musculotendon length was synchronous with peak EMG activation in the biceps femoris. It was significantly greater when compared to the semitendinosus. This study shows how stressful running is on the biceps femoris in the eccentric phase of running and another way of how testing could have been performed differently for this study. If the goal clinically is to attempt to stimulate muscle activity in the hamstrings after MFD or NDS, then the findings of the study did not support either. Perhaps muscle activation would change after a series of treatments in this area.

After looking at results from an objective perspective, the results were looked at in a subjective/objective form by using the DPAS and LEFS. On the DPAS, higher scores indicate functional limitations and decreased wellbeing. A score of 0 indicates no problems and a score of 64 is the highest. So similar to the LEFS data, subjects initially were free of difficulty and could function quite well. Houston et al[36] said that the Disablement in the Physically Active scale provides an overview of a patient's health status, to help guide individualize treatment and rehabilitation strategies. They suggested that the DPAS should be looked at it for guiding treatment. A change in 9 points for acute; change in 6 points for chronic are considered a minimal clinically-important difference (MCID) on the DPAS[38]. Based on the results we have collected, it supports their suggestion on how it can be used to guide treatment. There was an improvement in the DPAS scores mainly in the physical health after the intervention and 24 hours after the intervention. The Post LEFS for NDS dropped so much (could be because it has a very large Standard Deviation of 14.9). Although a score of 80 is the highest (indicates no dysfunction), so the subjects may have indicated they had lack of flexibility in their hamstrings, according to the LEFS scores they were already very high to begin with, so there was not much room to improve. A change of 9 scale points represents a minimal clinically important difference [40]

It is worth noting that the main effects for ROM and TOR at 45° were almost significant. Given the Observed Power values of .03 for DPAS and .09 for TOR at 45°, this study was likely under powered and the hypothesis testing was limited by small sample sizes. Clinical relevance may have been detected in these variables had more subjects participated in this study.

Limitations and Future Research

This study has several limitations. The number of participants and an unequal gender distribution among the groups was a limitation. The study was not able to be double blinded since the participants were able to see the treatment that they received. Due to the schedules of the participants and the researcher, the study was not able to be conducted over a longer period of time where there could have been significant results. DPAS and LEFS scores did not see significant improvements due to already “healthy scores”. Future studies should look at subjects that score lower on the LEFS or higher on the DPAS as inclusionary criteria to investigate true subjective changes in function and disability after treatment interventions. Researchers should look into how the improvement in physical health changes mental health scores in the DPAS. Future studies should examine how the improvement in physical health changes mental health scores in the DPAS.

There were issues with the calibration of the EMG and Biodex3 due to wiring coming off during testing, moving the limb from one side to another, and placement of the electrodes. There was a limitation on collecting the ROM since the digital goniometer would change the number when it was being held in the same place. Further investigations should consider the effects of manual and machine limitations when creating a study. Having positive results with NDS after one treatment and comparing to other studies, there should be further studies to investigate changes in hamstring flexibility after a regimented routine of treatments. Future studies should look into whether NDS make an improvement with strength in the lower extremity over a period of time. For RFD, we could have looked at the correlation the subjects’ maximal strength capacity and their voluntary rate of force development. Maffiuletti et al[39] suggest that factors influence maximal voluntary contraction strength and muscle cross-sectional area can influence rate of force development. Since muscle cross-sectional area was listed as an influence for rate of force development, ultrasound could have been used to read the depth of the muscle tissue of the hamstring being tested. It could have shown a correlation with muscle depth on strength, range of motion, and rate of force development.

CHAPTER V

CONCLUSION

The present findings indicated that both MFD and NDS are both methods to improve ROM without having an immediate impact on strength or performance. There was a positive finding with NDS on how the improvement in ROM lasts over time while MFD only has immediate improvements in ROM. Clinicians can look at these findings for methods of improving ROM without hindering performance like static stretching. Future research should look into the effects of MFD and NDS on the hamstring for a period of time to see if there is significant improvements with TOR, EMG, RFD, and ROM.

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APPRENDICES

Appendix A

Oklahoma State University Institutional Review Board

Date:	Thursday, March 16, 2017
IRB Application No	ED174
Proposal Title:	The Effects of Myofascial Decompression and Neurodynamic Sliding on the Hamstring for Division I Track and Field Athletes with Hamstring Tightness
Reviewed and Processed as:	Expedited

Status Recommended by Reviewer(s): Approved **Protocol Expires: 3/15/2018**

Principal Investigator(s):

Samantha Wagner	Jason DeFreitas	Douglas Smith
	198 CRC	180 CRC
Stillwater, OK 74078	Stillwater, OK 74078	Stillwater, OK 74078
Jennifer Volberding	Aric Warren	
180 Colvin Center	194 Colvin Center	
Stillwater, OK 74078	Stillwater, OK 74078	

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☐ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1.Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval. Protocol modifications requiring approval may include changes to the title, PI advisor, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms.
2.Submit a request for continuation if the study extends beyond the approval period. This continuation must receive IRB review and approval before the research can continue.
3.Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of the research; and
4.Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Dawnett Watkins 219 Scott Hall (phone: 405-744-5700, dawnett.watkins@okstate.edu).

Sincerely,

Hugh Crethar, Chair
Institutional Review Board

Appendix B

VERBAL SCRIPT FOR SUBJECT RECRUITMENT

Name of Study: The Effects of Myofascial Decompression and Neurodynamic Sliding for Hamstring Tightness on Division I Track Athletes

Script:

Hi, my name is Samantha Wagner. We are currently recruiting subjects for a study in the Applied Musculoskeletal and Human Performance Laboratory. The purpose of this study to examine the effects of myofascial decompression (cupping) and neurodynamic sliding (like a stretch) on hamstring range of motion, rate of force development, muscle activation, and isometric strength. This study will also benefit clinicians on the appropriate treatment for hamstring tightness on Division I track athletes.

To do this, you will have to report to the lab for two total times. The methods used will involve measuring your rate of force development and isometric strength on a physical therapy testing device as well as your hamstring range of motion and muscle activation that is measured using an EMG (sensors affixed to your skin). Your measurements will be recorded before and after a five minute treatment of myofascial decompression, neurodynamic sliding, or a 'heat treatment' using a diathermy machine on the hamstring. Measurements will be repeated again 24 hours after intervention. Three different questionnaires will be asked to be filled out before, immediately after intervention, and 24 hours after intervention.

Inclusion criteria consists of: Healthy Oklahoma State Track athlete between the ages of 18-25 who are in the Sprints, Jumps, or Multi (heptathlon, pentathlon, or decathlon) groups who complain of hamstring tightness and/or injury in the last calendar year and have less than 80° for Active Knee Extension test.

Exclusion criteria consists of: Past history or current neurological disorders or orthopedic diseases. Surgery of the lower extremity that involves an autograft on the tested leg. Past history of hamstring surgery. Subject is current hamstring injury, but is allowed to do maintenance rehab. Any form of myofascial therapy or neurodynamic techniques used in the week of testing. The subject has any of the cupping contraindications: unhealed wounds, active TB, leukemia, hemophilia, thrombocytopenia, fever, influenza, moderate/severe anemia, high blood pressure, cardiac conditions, late stages of pregnancy.

All risks and benefits of participation in this study and your rights as a research subject will be described in the consent form provided at the first session before testing begins. You will be required to sign this in order to show that you understand all that is contained in this form. As a participant, you will be contributing to the understanding of specific exercise prescriptions and the effects of fatigue that are caused by specific intensities. If you decide you do not want to participate at any time, you may drop out without penalty. If you are interested and would like to set up times for participation or have any questions, please call Samantha Wagner in Gallagher-Iba Athletic Training Room at 937-308-6354. If you would like to speak to my advisor or have any concerns, please contact Dr. Aric Warren at 918-561-1445.

Appendix C

ADULT CONSENT FORM
OKLAHOMA STATE UNIVERSITY

PROJECT TITLE: The Effects of Myofascial Decompression and Neurodynamic Sliding for Hamstring Tightness on Division I Track Athletes

INVESTIGATORS:
Samantha Wagner, LAT, ATC, CES- Oklahoma State University
Dr. Aric Warren- Oklahoma State University
Dr. Jason DeFreitas- Oklahoma State University
Dr. Doug Smith- Oklahoma State University
Dr. Jennifer Volberding- Oklahoma State University

PURPOSE:
This study will examine the effects of myofascial decompression (cupping) and neurodynamic sliding on hamstring range of motion, rate of force development, muscle activation, and isometric strength. This study will also benefit clinicians on the appropriate treatment for hamstring tightness on Division I track athletes at the ages of 18-25 years old.

PROCEDURES:
You will be asked to come in for two sessions. The first session will approximately will take one hour. The second session will approximately take 30 minutes. In the first session, you will be asked to fill out three questionnaires before intervention and two questionnaires after the intervention. The first questionnaire will provide us information on your past medical history of your hamstrings. The second and third questionnaires are patient outcome scales that provide us information how your hamstring affects activities of daily living and sport. Before the intervention, you will be assessed on your hamstring flexibility, strength, and how well the muscle contracts. Hamstring flexibility will be assessed by using the active knee extension test. You will be on your back with both the hip and knee positioned at 90° of flexion and then asked to extend lower leg until point of limitation. Hip flexion is maintained with the use of stationary board on the distal thigh and subject has to keep contact with board during extension. Non-tested leg will be strapped to the table with a belt on across the inferior thigh and over the anterior superior iliac spine. A Digital inclinometer will be used to measure hamstring flexibility. This is a device that is held next to your leg as you move it. We will measure these three times. After hamstring measurements, hamstring muscle strength testing and hamstring activation will be measured. Before testing, you will be prepped for the EMG. Skin will be prepped for placement of electrodes by shaving, abrading, and cleansing with alcohol. Electrodes will be placed on the hamstring. Then you will be seated on the Biodex and strapped on the chair with straps across the chest, waist, and legs to prevent excessive movement. While

you are seated on the Biodex, you will go through tests that will assess strength and muscle activation of the hamstring. After testing, you will draw a number out of a hat to be placed into one of the three intervention groups (myofascial decompression, neurodynamic sliding, and diathermy). For the myofascial decompression group, you will lie on your stomach and coca butter will be placed on your hamstring and calf. After application of the coca butter, five plastic cups will be placed on your hamstring and calf by using creating a vacuum with suction. Skin and tissue will be raised to a line on the cups. While you have the cups on, you will be asked to contract your thigh muscles 5 times and pump your ankle 5 times. The cups will be on for a total of five minutes. For the neurodynamic sliding group, you would sit on the treatment table bringing neck to the chest with bending the knee and pointing toes to the floor. After that movement you will then move your head to the ceiling, straighten the knee, and point the toes towards you. These two movements will be alternated for 60s and repeated 5 times, with rest period of 15s between sets. A metronome will be set at 30 for 15 full slides per minute to standardize the amount of slides per session The total session will take 5 minutes. For the diathermy group, you will lie on a treatment table on your stomach for five minutes while receiving diathermy treatment on your hamstring. After your intervention group, you will perform the range of motion, strength testing, and muscle activation testing of the hamstring that you performed before the intervention. After testing, you will fill out the patient outcome scales. 24 hours after testing, you will be asked to come into the lab and fill out the patient outcome scales along with performing the range of motion, strength testing, and muscle activation that was performed on day 1.

RISKS OF PARTICIPATION:
Risks associated with participation in this research study include possible hamstring injury during isometric strength, rate of production, and muscle activation testing. In order to assist with the offset of these risks, participants will be asked if they feel any pain or discomfort during testing, and any injury will be treated by Samantha Wagner. If you experience any hamstring discomfort and/or pain during or before testing please contact Samantha Wagner.

STANDARD OSU MEDICAL LIABILITY STATEMENT:
In case of injury or illness resulting from this study, emergency medical treatment will be available through Stillwater Medical Center. No funds have been set aside by Oklahoma State University to compensate you in the event of illness or injury.

BENEFITS OF PARTICIPATION:
You will know your hamstring range of motion, strength, and muscle activation. If you are interested, we will send you a copy of the results of the study when it is finished. This will help future clinicians with treating hamstring tightness in Division I track athletes.

CONFIDENTIALITY:
You will not be identified individually; we will be looking at the group as a whole. The records of this study will be kept private. Any written results will discuss group findings and will not include information that will identify you. Research records will be stored on a password protected computer in a locked office and only researchers and individuals responsible for

research oversight will have access to the records. Any written records will be locked in a drawer in a locked office that only researchers and individuals responsible for research oversight will have access to the records. Data will be destroyed three years after the study has been completed.

CONTACTS :
You may contact any of the researchers at the following addresses and phone numbers, should you desire to discuss your participation in the study and/or request information about the results of the study: Samantha Wagner, LAT, ATC, CES., 170 Gallagher Iba, Dept. of Athletic Training Oklahoma State University, Stillwater, OK 74078, (937) 308-6354. If you have questions about your rights as a research volunteer, you may contact the IRB Office at 223 Scott Hall, Stillwater, OK 74078, 405-744-3377 or irb@okstate.edu

PARTICIPANT RIGHTS:
I understand that my participation is voluntary, that there is no penalty for refusal to participate, and that I am free to withdraw my consent and participation in this project at any time, without penalty.

CONSENT DOCUMENTATION:
I have been fully informed about the procedures listed here. I am aware of what I will be asked to do and of the benefits of my participation. I also understand the following statements:
I affirm that I am 18 years of age or older.
Preface the signature lines with the following statement (expand if appropriate):
I have read and fully understand this consent form. I sign it freely and voluntarily. A copy of this form will be given to me. I hereby give permission for my participation in this study.

______________________________________ ______________________
Signature of Participant Date

I certify that I have personally explained this document before requesting that the participant sign it.

______________________________________ ______________________
Signature of Researcher Date

Appendix D

Hamstring Questionnaire Pre-Testing

Subject#____________ Group#_______________ Age________________________

Height _____________ Weight________________ Leg Dominance_______________

1) How many hamstring strains you have sustained to your right hamstring?

2) How long ago was the most recent injury / strain to your right hamstring?

3) How long have you experienced symptoms of tightness/pain/discomfort on the right hamstring?

4) How many hamstring strains you have sustained to your left hamstring?

5) How long ago was the most recent injury / strain to your left hamstring?

6) How long have you experienced symptoms of tightness/pain/discomfort on the left hamstring?

Appendix E

Disablement in the Physically Active Scale©

Instructions: Please answer **each statement** with one response by shading the square that most closely describes your problem(s) within the past **24 hours**. Each problem has possbile descriptors under each. Not all descriptors may apply to you but are given as common examples.

0- No problem
1- I have the problem(s), but it does not affect me
2- The problem(s) slightly affects me
3- The problem(s) moderately affects me
4- The problem(s) severely affects me

	No Problem	Does not affect	Slight	Moderate	Severe
DPA-Physical Summary Component	0	1	2	3	4
Pain- "Do I have **pain**?"	☐	☐	☐	☐	☐
Motion- "Do I have impaired **motion**?" Ex. Decreased range/ease of motion, flexibility, and/or increased stiffness	☐	☐	☐	☐	☐
Muscular Functioning- "Do I have impaired **muscle function**?" Ex. Decreased strength, power, endurance, and/or increased fatigue	☐	☐	☐	☐	☐
Stability- "Do I have impaired **stability**?" Ex. The injured area feels loose, gives out, or gives way	☐	☐	☐	☐	☐
Changing Directions- "Do I have difficulty with **changing directions** in activity?" Ex. Twisting, turning, starting/stopping, cutting, pivoting	☐	☐	☐	☐	☐
Daily Actions- "Do I have difficulty with **daily actions** that I would normally do?" Ex. Walking, squatting, getting up, lifting, carrying, bending over, reaching, and going up/down stairs	☐	☐	☐	☐	☐
Maintaing Positions- "Do I have difficulty **maintaining the same position** for a long period of time?" Ex. Standing, sitting, keeping the arm overhead, or sleeping	☐	☐	☐	☐	☐
Skill Performance- "Do I have difficulties with **performing skills** that are required for physical activity?"					
1) Ex. Running, jumping, kicking, throwing & catching	☐	☐	☐	☐	☐
2) Ex. Coordination, agility, precision & balance	☐	☐	☐	☐	☐
Overall Fitness- "Do I have difficulty maintaining my **fitness** level?" Ex. Conditioning, weight lifting & cardiovascular endurance	☐	☐	☐	☐	☐
Participation in Activites- "Do I have difficulty with **participating in activities**?"					
1) Ex. Particpating in leisure activities, hobbies, and games	☐	☐	☐	☐	☐
2) Ex. Participating in my sport(s) of preference	☐	☐	☐	☐	☐

DPA-Physical Score = _____/ 48

DPA-Mental Summary Component					
Well-Being- "Do I have difficulties with the following…?"	0	1	2	3	4
1) Increased uncertainty, stress, pressure, and/or anxiety	☐	☐	☐	☐	☐
2) Altered relationships with team, friends, and/or colleagues	☐	☐	☐	☐	☐
3) Decreased overall energy	☐	☐	☐	☐	☐
4) Changes in my mood and/or increased frustration	☐	☐	☐	☐	☐

DPA-Mental Score = _____/ 16

DPA-Total Score = _____/ 64

(DPA-Mental + DPA-Physical)

Appendix F

Instructions

We are interested in knowing whether you are having any difficulty at all with the activities listed below **because of your lower limb problem** for which you are currently seeking attention. Please provide an answer for **each** activity.

Today, *do you* or *would you* have any difficulty at all with:

Activities	Extreme difficulty or unable to perform activity	Quite a bit of difficulty	Moderate difficulty	A little bit of difficulty	No difficulty
1. Any of your usual work, housework or school activities.	0	1	2	3	4
2. Your usual hobbies, recreational or sporting activities.	0	1	2	3	4
3. Getting into or out of the bath.	0	1	2	3	4
4. Walking between rooms.	0	1	2	3	4
5. Putting on your shoes or socks.	0	1	2	3	4
6. Squatting.	0	1	2	3	4
7. Lifting an object, like a bag of groceries from the floor.	0	1	2	3	4
8. Performing light activities around your home.	0	1	2	3	4
9. Performing heavy activities around your home.	0	1	2	3	4
10. Getting into or out of a car.	0	1	2	3	4
11. Walking 2 blocks.	0	1	2	3	4
12. Walking a mile.	0	1	2	3	4
13. Going up or down 10 stairs (about 1 flight of stairs).	0	1	2	3	4
14. Standing for 1 hour.	0	1	2	3	4
15. Sitting for 1 hour.	0	1	2	3	4
16. Running on even ground.	0	1	2	3	4
17. Running on uneven ground.	0	1	2	3	4
18. Making sharp turns while running fast.	0	1	2	3	4
19. Hopping.	0	1	2	3	4
20. Rolling over in bed.	0	1	2	3	4
Column Totals:	0	1	2	3	4

Page 2

Appendix G

Albedah A, Khalil M, Elolemy A, et al. The Use of Wet Cupping for Persistent Nonspecific Low Back Pain: Randomized Controlled Clinical Trial. The J of Alter and Complement Med. 2015;21(8):504-508. doi:10.1089/acm.2015.0065.

The purpose of this study is to see if wet cupping can help with nonspecific low back pain. The study is a randomized and controlled study. They were selected into intervention groups which received three sessions of wet cupping per week for two weeks. The participants were allowed a maximum of three 500-mg acetaminophen tablets per day for both groups. Pain and functionality were measured at baseline, 2 weeks after intervention, and 4 weeks after intervention with NRS score, McGill Present Pain Intensity questionnaire, and Oswetry Disability Questionnaire. 80 of the 123 participants participated in the study. 40 were placed in the intervention group. 40 were placed in the control group. There was a significance in the NRS score for cupping compared to the control group. There was a significant decrease in the ODQ score for the cupping group compared to the control group. Within the cupping group, there was a statistical significant decrease between the two week and four week points compared to the baseline. The study proved that wet cupping can reduce pain and improve disability associated with persistent nonspecific low back pain.

Babu KV. Immediate Effect Of Neurodynamic Sliding Technique Versus Mulligan Bent Leg Raise Technique On Hamstring Flexibility In Asymptomatic Individuals. Inter J of Physiotherapy. 2015;2(4). doi:10.15621/ijphy/2015/v2i4/67747.

This study looks at neurodynamics sliding technique and Mulligan bent leg raise technique for hamstring flexibility. The study is an experimental study design with a neurodynamic sliding group and mulligan bent leg raise group. There are 80 participants both male and female who are 18 to 40 years old. The participants are asymptomatic of hamstring tightness and have less than 75 degrees SLR ROM. The neurodynamic sliding consists of alternating movements of knee extension/ankle dorsiflexion with cervical extension, and knee flexion/ankle plantar flexion with cervical flexion. The movements were performed for 60 seconds and repeated for 5 times. The mulligan bent leg raise had the patient in a supine position. The therapist placed one hand under subject's knee and clasped under subject's heel with other hand. The hip is flexed as much as possible while keeping the knee flexed. The patient pushes their heel against the therapist's resistance. The therapist raises the leg and increasing knee flexion and performs hip abduction at same time with three repetition of isometric contraction of the hamstring for 5 seconds. For flexibility measurement, passive SLR was used to determine changes in hamstring muscle extensibility. They are in a supine position. The axis of the goniometer was placed on the greater trochanter. One arm is placed parallel to the table. The other arm is placed in line of the head of the fibula and fibular malleolus. The paired 't'test and Wilcoxon test is used for analysis pre-intervention and post-intervention. There was no statistically or clinical significance between the groups. There was significant difference within the groups. The article shows that both methods are effective on improving hamstring flexibility for asymptomatic individuals with limited SLR ROM.

Binkley JM, Stratford PW, Lott SA, Riddle DL. The Lower Extremity Functional Scale (LEFS): scale development, measurement properties, and clinical application. North Amer Ortho Rehab Res Network. Phys Ther. 1999 Apr;79(4):371-83.

This study looked at the reliability, construct validity, and sensitivity to change of the Lower Extremity Functional Scale (LEFS). The LEFS assessed 107 patients with musculoskeletal injuries. They had an initial assessment, 24 to 48 hours after initial assessment, and weekly intervals. A type 2,1 intraclass correlation assessed the test-retest reliability. Spearman rank-order correlation coefficients were used to examine the change of each patient. Pearson correlation and one way ANOVA examined validity. The results present that the LEFS is reliable, sensitive, and efficient for research and clinical plans for patients.

Cao H, Han M, Li X, et al. Clinical research evidence of cupping therapy in China: a systematic literature review. BMC Complementary and Alternative Medicine BMC Complement Altern Med. 2010;10(1). doi:10.1186/1472-6882-10-70.

This article was a systematic review of cupping therapy in China. There were different methods of cupping and type of cups used. There were bamboo cups, glasses or earthen cups. The different types of cupping were flaming heating power, bleeding or wet cupping, moving cupping, and empty cupping. Heat powering cupping utilizes a flame to achieve suction inside the cup. Bleeding cupping involves small incisions with a triangle-edged needle to cause bleeding. Moving cupping is when the clinician controls the suction by moving the cup in one direction. Empty cupping is when the cups are removed after suction without delay. 550 studies were collected Chinese databases. Evidence from randomized controlled trials are considered gold standard for therapeutic evaluation. The main interventions were bleeding cupping (58.0%), retained cupping (18.2%), moving cupping (8.7%), medicinal cupping (5.5%), flash cupping (1.3%), water cupping (0.9%), and needle cupping (0.6%). The studies used cupping to treat pain, herpes zoster, cough or asthma, acne, common cold, urticara, lateral femoral cutaneous neuritis, cervical spondylosis, lumbar sprain, and other conditions. The article said that overall cupping therapy improved on numbers or quality by describing protocols, experience practitioners, period and frequency of treatment, and blinding of the procedure. There is unclear evidence of the therapeutic effect of cupping, appropriate duration of cupping therapy, syndrome differentiation for acupoints selection, and frequency of cupping therapy. Overall, studies have improved in quality but there needs to be set standards for protocols in the studies.

Cao H, Li X, Liu J. An Updated Review of the Efficacy of Cupping Therapy. PLoS ONE. 2012;7(2). doi:10.1371/journal.pone.0031793.

This article is an updated systematic review that Cao wrote on Cupping therapy from 2010. It selected the same 550 articles that were used in 2010 and went more in-depth in the analysis between the articles. The articles were collected from research database with the keywords of *cupping therapy, bleeding cupping, wet cupping, dry cupping, flash cupping, herbal cupping, moving cupping, needling cupping, and retained cupping.* The quality of trials were categorized into low, unclear, and high risk of bias. The most common forms of interventions used were wet cupping, retained cupping, and moving cupping. There were a total of 56 disease and/or symptoms treated by cupping therapy. The systematic review showed that cupping therapy appears to be effective for various diseases. The main limitation of the studies were that they were high risk of bias due to quality, the size of the sample sizes, and blinding the participants and researchers.

Castellote-Caballero Y, Valenza M, Martín-Martín L, Cabrera-Martos I, Puentedura E, Fernández-de-las-Peñas C. Effects of a neurodynamic sliding technique on hamstring flexibility in healthy male soccer players. A pilot study. Phys Thera In Sport [serial online]. August 2013;14(3):156-162. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed August 25, 2016.

The study looked at neurodynamic sliding on college age male soccer players. The two groups were an intervention group who performed neurodynamic sliding technique three times in a week with five reps of 60s on the hamstring and the nonintervention group just continued normal soccer activities. Hamstring ROM was measured with passive single-leg raise. Both presented with less than 75 degrees of ROM. Intervention group increased by 9 degrees and nonintervention group increased by less than 2 degrees. The study showed how significant neurodynamic sliding has on hamstring ROM compared to normal stretching and other athletic activities.

Castellote-Caballero Y, Valenza MC, Puentedura EJ, Fernández-de-las-Peñas C, Alburquerque-Sendín F. Immediate Effects of Neurodynamic Sliding versus Muscle Stretching on Hamstring Flexibility in Subjects with Short Hamstring Syndrome. J of Sports Med. 2014;2014:127471. doi:10.1155/2014/127471.

This article looks at the immediate effects of neurodynamic sliding versus muscle stretching on hamstring flexibility in subjects with short hamstring syndrome. There were 120 subjects ranging from 20-45 years old. They were divided into a neurodynamic sliding group, hamstring stretching group, and placebo group, which consisted of foot intrinsic joint mobilizations. The measurement of hamstring flexibility was passive SLR test. Each subject was measured 3 times using an universal goniometer. The patient was supine and foot in dorsiflexion as the examiner held onto the talus and hip. The stationary arm was parallel to the table. The moving arm was placed between the head of the fibula and lateral malleolus. For the passive stretching group, the subjects were put into the SLR position and the researcher passively position the subject into SLR until there was resistance of movement. The position was held for 30 seconds and repeated 5 times. For the neurodynamic sliding group, the subjects were supine with neck and thoracic spine supported in a forward neck flexion. Hip flexion and knee flexion was altnernated with hip and knee extension. The treatment lasted 180 seconds. SLR values were significantly higher for both neurodynamic and stretching group compared to control group and the neurodynamic group compared to the stretching group. Both groups had significant improvement compared to their baselines. The findings show that neurodynamic sliding will increase short-term hamstring flexibility when compared to passive stretching.

Chen B, Li M- Y, Liu P- D, Guo Y, Chen Z- L. Alternative medicine: an update on cupping therapy. Qjm. 2014;108(7):523-525. doi:10.1093/qjmed/hcu227.

This article was a systematic review of cupping therapy in the last five years. It is considered alternative medicine similar to acupuncture. It is popular in countries like China, Korea, Japan, and Saudi Arabia. Cupping is used to treat pain, cardiovascular diseases, immune system diseases, and metabolic diseases, such as migraine, low back pain, fibromyalgia, shoulder pain, chronic nonspecific neck pain, angina, arthritis, high blood pressure, ischemic and inflammatory myocardial conditions, herpes zoster, Behcet disease, secondary amenorrhea, depression and anxiety, fatigue, metabolic syndrome and acne vulgaris. It has shown that there is low evidence for herpes zoster, facial paralysis, acne and cervical spondylosis. There are ten protocols that applicable for the clinic. Cupping can adjust skin blood flow, make changes in biomechanical properties of the skin, increase immediate pressure pain thresholds, quickly reduce inflammation. Adverse effects of cupping are post-inflammatory hyperpigmentation and keloids.

Clark R, Bryant A, Culgan J, Hartley B. The effects of eccentric hamstring strength training on dynamic jumping performance and isokinetic strength parameters: a pilot study on the implications for the prevention of hamstring injuries. Phys Ther In Sport [serial online]. May 2005;6(2):67-73. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed August 30, 2016.

The purpose of this study is to see if Nordic hamstring exercise has a relationship with length-tension relationship, hamstring strength levels, and lower body power output. There is pre- and post-training testing with an isokinetic dynamometer of the quadriceps and hamstrings at 60 degree s. Lower body strength and dynamic output is assessed with peak torque, position of peak torque, and vertical jump. The training lasted for four weeks. There was a reduction in peak torque for the quadriceps from pre- to post-training. There was a significant effect for the position of the hamstring peak torque with an increase in knee flexion toward knee extension in the dominant leg versus the nondominant leg. There was also an increase in position of hamstring peak torque in knee flexion toward full extension in post-training sessions versus pre-training sessions. There was a significant increase in vertical jump height between pre- and post-training sessions. Based on the results, Nordic hamstring exercise is an effective method for both enhancing performance and reducing injury.

Cohen SB, Rangavajjula A, Vyas D, Bradley JP. Functional Results and Outcomes After Repair of Proximal Hamstring Avulsions. AJMS. 2012;40(9):2092-2098. doi:10.1177/0363546512456012.

The study looks into postsurgical outcomes in active patients after acute and chronic proximal hamstring tears. There were fifty-two patients had proximal hamstring repair surgery. They completed the Lower Extremity Functional Scale and the Marx Activity Scale. All of the patients had the same surgical repair in regards to the 5 suture anchors on the ischial tuberosity. The rehabilitation protocol is 6-8 weeks. It incorporates progressive weightbearing and range of motion. 51 of the 52 patients were satisfied with their surgery. The LEFS and Marx Activity scale indicate successful outcomes. There was no significant difference between the different scales and acute vs chronic hamstring injury. Patients with acute hamstring repairs had higher functional and hamstring score, and strength.

DaPrato C. Common Impairments addressed with MFD.

This lectured explained the process of using myofascial decompression on the hamstring. It showed different ways to diagnose hamstring tightness for the protocol. It showed that you put 5 plastic cup along the hamstring and gastrocnemius. You place two between the ischial tuberosity and the popliteal fossa. One cup is placed in the popliteal fossa. Two cups are placed on the gastrocnemius. One is placed on the lateral head and the other is placed between the head of the gastrocnemius muscle and the gastrocnemius tendon. The cups follow the fascia line of the biceps femoris and the gastrocnemius muscles.

Ellis RF, Hing WA. Neural Mobilization: A Systematic Review of Randomized Controlled Trials with an Analysis of Therapeutic Efficacy. J of Manual & Manipulative Thera. 2008;16(1):8-22. doi:10.1179/106698108790818594

This paper is a randomized controlled trial of neural mobilization of 11 articles. They were scored on a PEDro scale. Of the 11 studies, there were 6 different categories or types of treatment used. 8 of the 11 studies concluded that there was a positive benefit from using neural mobilization in the treatment of altered neurodynamics or neurodynamic dysfunction. Three of the 11 concluded neutral benefit. Nine of the 11 studies demonstrated moderate methodological quality. There was inconclusive evidence to support the use of slump stretches and combinations of neural mobilization techniques. Neural mobilization is advocated for treatment of neurodynamic dysfunction and a positive therapeutic treatment.

Granter, R. An Introduction to Vacuum Cupping. Sportex Dynamics [serial online]. October 2011;(30):15-18. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed August 25, 2016

This article presents a description of myofascial decompression technique known as cupping. It provides the history of the technique, the equipment used, and the different parameters and different techniques of cupping. It provides pros and cons to the modern technique of using a pump for the vacuum versus the flame vacuum technique. The online version of the article goes into depth with videos by the author.

Guex K, Borloz S, Millet G. Influence of Strength and Flexibility of a Swing Phase- Specific Hamstring Eccentric Program in Sprinters' General Preparation. J Strength Cond Res (Lippincott Williams & Wilkins) [serial online]. February 2016;30(2):525-532. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed September 6, 2016.

This study looks at the influence of strength and flexibility during the swing phase for sprinters by measuring strength with an isokinetic dynamometry and flexibility with passive knee extension test. The researchers are looking into this because hamstring sprains in sprinters occur during late swing phase when the hamstring is eccentrically contracted. The risk factors for hamstring strains are having a lower hamstring to quad ratio and poor hamstring flexibility. The subjects were twenty national-level sprinters ranging 16-26 years old, who performed an isokinetic and flexibility pre-intervention assessment. Hamstring flexibility was measured using the PKE. Isokinetic dynamometer was calibrated before strength testing. The hip flexion angle was at 80 degrees and the knee ROM was set at 100 degrees. The isokinetic testing involves 4 maximal concentric knee flexion-extensions at 60 degrees/s, 5 maximal concentric knee-extensions at 240 degrees/s, 4 maximal eccentric knee extensions at 30 degrees/s, and 5 maximal eccentric knee extensions at 120 degrees/s. They were split into a controlled and eccentric training group. The eccentric group performed eccentric training for 6 weeks. The eccentric training involved eccentric knee extension on the hamstring curl machine and eccentric hip flexion on the hip trainer machine. They used ANOVA to analyze the data. In the eccentric training group, peak torque significantly increased in Hcon60, Hcon240, Hecc30, Hecc120, and Qcon240. In the control group, the peak torque increased in Hecc30, Hecc120, and Qcon240. For PKE, the eccentric group had a significant changed in muscle length. In the control group for PKE, there was no significance difference. Based on the information from this study, eccentric training has benefits for sprinters with muscle strength and length.

Higashihara A, Nagano Y, Ono T, Fukubayashi T. Relationship between the peak time of hamstring stretch and activation during sprinting. Euro J of Sport Science [serial online]. February 2016;16(1):36-41. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed August 25, 2016.

This study looked at the relationship between peak time of hamstring stretch and activation during sprinting on college age sprinters. Data was collected with a portable EMG on the right biceps femoris long head and semitendinosus muscles. All participants performed a warm-up and 40m sprint for testing once. Running cycle was analyzed on the right leg. Horizontal speed and time of peak hamstring length were calculated. Peak musculotendon length of semitendinosus was significantly different earlier compared to biceps femoris long head. Significant differences were observed between time of peak musculotendon length and EMG activation in semitendinosus muscle. The findings showed that biceps femoris long head is synchronized with peak activation which shows that biceps femoris long head is exposed to instaneous high tensile force during late swing phase of running.

Higashitara A, Ono T, Kubota J, Okuwaki T, Fukubayashi T. Functional differences in the activity of the hamstring muscles with increasing running speed. Journal of Sports Sciences [serial online]. August 2010;28(10):1085-1092. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed September 6, 2016.

This study looks at the EMG activity of the biceps femoris and semitendinosus due to the architectural differences and variation in the muscle weight, pennation angle muscle volume, physiological cross-sectional area, and muscle fibre length. The biceps femoris long head tends to get injured more than semitendinosus during late swing phase and stance phase of running. Eight healthy male sprinters participated in the study. They were instructed to run on a Woodway treadmill with 0 degrees of inclination at 50%, 75%, 85%, and 95% of maximum velocity for ten strides each. Participants had 25mm reflective markers located on the acromion, greater trochanter, lateral femoral epicondyle, and later malleolus on the left side facing the camera. EMG activity was recorded on biceps femoris long head and semitendinosus by using surface Ag/AgCl electrodes. The interelectrode placement was 30mm and their placement was on the muscle belly during isometric contractions detected by palpation. Joint angle and EMG activity was divided into four phases of running (stance, early swing, middle swing, and late swing). The EMG signals were converted to a 2-kHz sampling rate. ANOVA was used to analyzed the data. Maximum activation occurred during the late swing phase of all running velocities. Significant difference in activation occurred during middle swing phase where semitendinosus was greater at 75%, 85%, and 95% max. Peak time of EMG activity occurred for biceps femoris long head and semitendinosus during the stance phase and late swing phase. The results from the study showed that complex neuromuscular coordination pattern appears to occur during running cycle when close to maximum speed.

Houston MN, Hoch JM, Lunen BLV, Hoch MC. The development of summary components for the Disablement in the Physically Active scale in collegiate athletes. Qual Life Res Quality of Life Research. 2015;24(11):2657-2662. doi:10.1007/s11136-015-1007-6.

The purpose of this article is to analyze the Disablement in the Physically Active scale. The study used 467 collegiate athletes who filled out a demographic form and DPAS. The responses on the DPAS were on a 5 point likert scale. The scale had 16 questions that related to impairment, functional limitations, disability, and quality of life. The study showed that the DPAS provides an insight on a patient’s health status, analyzing the scale can provide information on individualizing treatment and rehabilitation plans.

Lobacz ADT. Neurodynamic Mobilizations for Hamstring Strain Injuries. Athletic Training & Sports Health Care. 2015;7(3):85-88. doi:10.3928/19425864-20150422-02.

This article explains the purpose and technique of neurodynamic mobilizations for hamstring injuries. It explains how actively or passively mobilizing the nerve can restore the nerve’s ability to withstand the regular stress of activity through improved nerve mobility, circulation, viscoelasticity, and reducing sensitivity. Hamstring strains can cause an inflamed sciatic nerve. Nerve glides are performed with the patient supine with hip flexion at 90 degrees. The patient actively and slowly extend the knee while keeping the hip flexed at 90 degrees. While they extend the knee, the patient dorsiflex and externally rotate the leg for 5 seconds. Nerve tensioners are performed while seated at the end of the table with the knee in full extension and cervical spine in flexion. The patient will dorsiflex and plantarflex for 20 seconds. There is another tensioner technique which involves the patient invert and evert the ankle while keeping the rest of the leg still. Neurodynamic mobilization have been useful in treating hamstring tightness and discomfort and should be added to an approach to hamstring strain injury management.

Loutsch R, Baker R, May J, Nasypany A. Reactive Neuromuscular Training Results in Immediate and Long Term Improvements in Measures of Hamstring Flexibility: A Case Report. Inter J of Sports Phys Thera [serial online]. June 2015;10(3):371-377. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed August 25, 2016.

This article is based off of a case study of a female softball player who complains of hamstring tightness. Patient was tested by doing ASLR, PSLR, finger to floor test, sit and reach modified Shober, seated sacral angle, and standing sacral angle. After examination, patient was believed to have TED. The patient was treated with RNT technique applied on the abdomen, sternum, and ASISs in an AP force. After treatment, patient had an increase in hamstring ROM. This case study shows that RNT technique can be used as a screening tool and treatment for patients with signs of hamstring tightness.

Macdonald GZ, Penney MD, Mullaley ME, et al. An Acute Bout of Self-Myofascial Release Increases Range of Motion Without a Subsequent Decrease in Muscle Activation or Force. *J of Strength and Cond Res*. 2013;27(3):812-821. doi:10.1519/jsc.0b013e31825c2bc1.

This article looked at the effects of self-myofascial release by using foam rolling on knee extensor force, muscle activation, and range of motion. Study used 11 healthy and physically active males. Subjects were placed in a control group or SMR group. The SMR group would perform 2 1 minute bouts of foam rolling. They were tested before, 2 minutes, and 10 minutes after intervention. The study showed an increased significance in their ROM at 2 and 10 minutes after SMR. There was no significant change in their force. This study showed that SMR can improve ROM without having an effect on performance.

Maffiuletti, N. A., Aagaard, P., Blazevich, A. J., Folland, J., Tillin, N., & Duchateau, J. (2016). Rate of force development: physiological and methodological . Eur J Appl Physiol,116, 1091-1116

This article provides evidence-based practical recommendations for uses of rate of force development in the laboratory and clinical settings. It goes over the physiologically components of rate of force development and methods. This article shows how rate of force development can demonstrate how to analyze explosive voluntary contractions, which can be improved by explosive and resistance strength training.

Malliaropoulos N, Mendiguchia J, Maffulli N, et al. Hamstring exercises for track and field athletes: injury and exercise biomechanics, and possible implications for exercise selection and primary prevention. Br J Sports Med. [serial online]. September 15, 2012;46(12):846-851. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed September 6, 2016.

This article is a literature review looking into injury and exercise biomechanics and how exercise selection has an impact on injury prevention for track and field athletes. The study mainly looked at sprinters and the mechanisms for hamstring strains. Based on the research, hamstring strains mainly occur during the stance and swing phase of sprinting when the athlete tries to get to top speed and the hamstrings mainly the biceps femoris long head is eccentrically contracted. The implications of core stability, range of motion, architecture of the muscles, fatigue, neuromuscular control make sprinters more susceptible to hamstring strains. Due to the mechanism and implications, the researchers looked into eccentric training for sprinters to see if it enhanced muscle mass, strength, power and ROM. The research supports that progressively increasing the length of muscle groups and modifying ground forces will gradually improve outer range muscle strength and protect against future risk. The conclusion of this study is that hamstring injury prevention should include specific muscle strengthening and eccentric training protocols like the Nordic hamstring protocol can reduce hamstring injuries.

Mendiguchia J, Martinez-Ruiz E, Mendez-Villanueva A, et al. Effects of hamstring-emphasized neuromuscular training on strength and sprinting mechanics in football players. Scand J of Med & Science in Sports [serial online]. December 2015;25(6):e621-e629. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed August 25, 2016.

This study looked at plyometrics as neuromuscular training and it's effects on muscular strength and sprinting mechanics. Training was for 14 sessions in a 7 week period. Concentric quadriceps peak torque, concentric hamstring peak torque, and eccentric hamstring peak torque were tested on Biodex pre and post test. Sprinting mechanics was tested by having participants perform two 50m sprints. There was significant improvement in muscular strength for all muscular testing. There was no significance in sprinting mechanics. There was an improvement in quadriceps/hamstring ratio. This study shows that neuromuscular training does have an effect on firing patterns and contribute to change in muscular strength.

Nicola TL, Jewison DJ. The Anatomy and Biomechanics of Running. Clinics in Sports Medicine. 2012;31(2):187-201. doi:10.1016/j.csm.2011.10.001.

This article explains the anatomy and biomechanics of running. It broke down the different phases of running and explained the importance of each body part during the running cycle. It showed how certain anatomical defaults on runners can have an impact on their running form and potential injury.

Oliver G, Stone A, Washington J. Hamstring and Gluteal Muscle Activation During the Assessment of Dynamic Movements. Inter J of Ath Thera & Train [serial online]. July 2016;21(4):30-33. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed August 25, 2016.

Study looked at hamstring and gluteal medius activation during dynamic movement. The purpose of the study is to have participants perform movements that mimic injury movements by having participants perform single leg step down and single leg lateral hop. Study used an EMG to record muscle activation. Both movement showed high muscle activation with hamstring and gluteal medius muscles. Based on the data collected, movements should be considered for functional movement testing and screening.

Opar DA, Williams MD, Shield AJ. Hamstring Strain Injuries. Sports Medicine. 2012;42(3):209-226. doi:10.2165/11594800-000000000-00000.

This article is a literature review regarding factors that lead to hamstring injury and re-injury. The article discusses how sprinting events is the group in track & field with the most hamstring injuries. It explains the biomechanics of running and what areas of the running gait makes a sprinter more susceptible for hamstring injury. Terminal swing and early stance phase are the most common part of the running gait where hamstring injuries occur. It is due to the hamstrings being put in the greatest stretch and greatest peak in activation while the hamstring is eccentrically contracting. Anatomically Biceps Femoris Long head and short head are innervated by different nerve branches, which causes uncoordinated contraction by the biceps femoris heads. The article discusses unaltered factors of hamstring injury being age, previous injury, and ethnicity. Altered factors for hamstring injury are strength imbalances, flexibility, and fatigue. For strength imbalances, it goes over overall strength, bilateral asymmetry, and hamstring: quadriceps strength ratio, and angle of peak knee flexion torque. The article addresses risk factors to reduce the risk of hamstring injury. It talks about eccentric training, flexibility training, and strength imbalance correction. Combining all of those factors to create a rehabilitation plan can reduce the possibility of having hamstring injury.

Pagare V, Ganacharya P, Sareen A, Palekar T. Effect of Neurodynamic Sliding Technique Versus Static Stretching on Hamstring Flexibility in Football Players with Short Hamstring Syndrome. Journal Of Musculoskeletal Research [serial online]. June 2014;17(2):1-8. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed August 25, 2016.

Study compared static stretching and neurodynamic sliding technique on college age football players. Single leg raise (SLR) with a goniometer were used to measure hamstring ROM. ROM was measured for pretest and post test after each session There were three sessions. Both groups showed significant improvement in ROM. All participants before the study had less than 75 degrees and improved to greater than 75 degrees of motion. There was no significance between the groups. Both methods are effective for increasing ROM. Study suggests looking into participants with past history of hamstring injury, functional performance, and torque production.

Palmer TB, Hawkey MJ, Thiele RM, et al. The influence of athletic status on maximal and rapid isometric torque characteristics and postural balance performance in Division I female soccer athletes and non-athlete controls. *Clinical Physiology and Functional Imaging*. 2014;35(4):314-322. doi:10.1111/cpf.12167.

This study looked at the influence of maximal and isometric torque on the hip extensor muscle and postural balance of female collegiate soccer players versus non-athletes. Maximal and isometric torque was assessed by having participants perform two maximal voluntary contractions (MVCs) on the hip extensors. Peak torque and rate of development were evaluated during three phases of each muscle contraction. Postural balance was assessed by using balance testing device that measured their sway index. The results showed that rate of development in athletes were greater than non-athletes. Athletes had a lower sway index versus non-athletes. This study showed us how strength and balance can show athletic potential.

Park J, Cha J, Kim H, Asakawa Y. Immediate effects of a neurodynamic sciatic nerve sliding technique on hamstring flexibility and postural balance in healthy adults. PTRS Phys Ther Rehab Science. 2014;3(1):38-42. doi:10.14474/ptrs.2014.3.1.38.

The purpose of this study is to see the immediate effects of neurodynamic sciatic nerve sliding on hamstring flexibility and postural balance. The study uses 24 healthy adults with the inclusion criteria of hamstring flexibility exceeding 70 degrees on passive SLR and being the age between 20 and 30 years. The exclusion criteria was any neurological or orthopedic diseases affecting their lower extremity or a history of hamstring surgery. The passive SLR was measure with the pelvis and trunk fixed on the bed. The axis of the goniometer was on the greater trochanter. The fixed arm was parallel with the bed and the moving arm was inline with the lateral malleolus and head of the fibula. To measure balance, subjects were asked to stand on dominant leg and keep posture for 20s. They assessed the balance by X-speed (mediolateral sway), Y-speed (anteriorposterior sway), and velocity moment were measured. The subjects performed the sliders by sitting on the bed. They performed cervical and thoracic flexion while doing knee flexion and ankle plantar flexion. Then they did cervical and thoracic extension along with knee flexion and ankle plantar flexion. They did for one minute five times. The study showed significant improvement with hamstring flexibility and balance with the use of neurodynamic sciatic nerve technique.

Pinto M, Wilheim E, Tricoli V, Pinto R, Blazevich A. Differential Effects of 30- VS. 60-Second Static Muscle Stretching on Vertical Jump Performance. J Strength Cond Res (Lippincott Williams & Wilkins) [serial online]. December 2014;28(12):3440-3446. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed August 30, 2016.

The purpose of this study is to see if no static stretching, 30s of static stretching, or 60s of static stretching has an impact on the countermovement jump test. The study was performed on college age males who are physically active. They were brought into the lab four times. The first time was to get familiar with the test and the stretching protocol. The other times were randomized into their groups and did testing. The stretching protocol entailed of straight-leg calf stretch, supine single-leg hamstring stretch, supine hip flexion stretch, and lying quadriceps stretch with hip extension. They were performed for either 30s or 60s per muscle group. Jump height was significantly less for 60s versus no stretch. Power output was small but significant between 60s versus no stretch. There was no significance between no stretch versus 30s and 30s versus 60s.

Puentedura EJ, Huijbregts PA, Celeste S, et al. Immediate effects of quantified hamstring stretching: Hold-relax proprioceptive neuromuscular facilitation versus static stretching. Phys Thera in Sport. 2011;12(3):122-126. doi:10.1016/j.ptsp.2011.02.006.

This study looks at the immediate effects of proprioceptive neuromuscular facilitation stretching versus static stretching of the hamstring on hamstring flexibility of healthy subjects. Thirty subjects (13 female; mean age 25.7 +/- 3.0 years) with limited hamstring flexibility were randomly assigned to the two groups. Subjects performed active knee extension to measure hamstring flexibility. AKE involve the subjects supine on a table with hip and measured leg at 90 degrees. The measurement was taken with a digital inclinometer after the knee was extended while staying in contact with a board by their thigh. The subjects were stretched by using a pulley system that is attached to their ankle with 5% of their body weight as the stretching force. Static stretching was performed for 30s twice with 10s of rest between sets. Static stretching was performed for a total of 80s. For PNF stretching, the examiner lengthened the hamstring to end of range while the subject holds 10s of maximal isometric contraction followed by 10s of passive stretch on the pulley system for four repetitions to match the 80s of SS. Subjects were measured pre/post intervention. There was a significant difference among the groups after treatment. There was no significant difference between the two groups.

Rozenfeld E, Kalichman L. New is the well-forgotten old: The use of dry cupping in musculoskeletal medicine. J of Bodywork & Movement Thera [serial online]. January 2016;20(1):173-178. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed August 25, 2016.

This systematic review goes over the modality of cupping. It goes over the history of how it started with the Egyptians and made it's way through Eastern medicine and Western medicine. It describes the different methods of cupping by using fire as a vaccum or the mechanical pump that is used more today. It explains the mechanical and physiological effects. The literature supports that using a larger cup with more pressure for approximately ten minutes provides the best physiological effects. It goes over the different physiological theories on circulation, immune system, and neuromuscular system, and having similar principles as acupuncture and acupressure. Treatment is mostly used for musculoskeletal pain and presents best results versus other uses for actual pain and increasing function and ROM. Literature presents that there are little complications with cupping and presents results physiologically.

Shacklock M. Neurodynamics. Physiotherapy. 1995;81(1):9-16.

This article goes over the principles of neurodynamics. Neurodynamics is an approach to treating pain. It helps make mechanics of the nervous system so posture and movement is pain-free. It originated from tests that move neural structures like single leg raise, passive neck flexion, prone knee bend, and upper limb tension. Musculoskeletal system is the mechanical interface of the nervous system. It consists of the central and peripheral components which control the movement of muscles and limbs. Neuromechanical responses are joint angulation and anatomical destination of the nerves. Certain movements has an effect on the nerve elongating, sliding, and tension. There are interactions between mechanical and physiological mechanisms of the nervous system. Non-uniform pattern is determined by anatomical and mechanical characteristics along with combination and order of body movements. Neurodynamics is the link between mechanical and physiological types of mechanisms.

Sharma S, Balthillaya G, Rao R, Mani R. Short term effectiveness of neural sliders and neural tensioners as an adjunct to static stretching of hamstrings on knee extension angle in healthy individuals: A randomized controlled trial. Phys Thera In Sport [serial online]. January 2016;17:30-37. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed August 25, 2016.

Study compared static stretching (SS) , SS with neural-tensors (NT), and neural-sliders (NS) with SS on healthy physical therapy students. Study found significant difference with SS compared to SS with NT and SS with NS. There was no significant difference between SS with NT and SS and NS. They compared ROM by Knee Extension Angle (KEA) dues to positioning and how it prevents pelvic tilt and hip capsule tension. Findings showed increased ROM by adding NS or NT with SS due to improvement in mechanoreceptors which improved flexibility. This study showed that neurodynamic techniques does improve ROM and flexibility.

Sullivan KM, Silvey DBJ, Button DC, Behm DG. Roller- Massager Application to the Hamstrings Increases Sit-and-Reach Range of Motion Within Five to Ten Seconds Without Performance Impairments. Inter J of Sports Phys Thera. 2013;8(3):228-236.

This article looked at roller-massager application to the hamstring and its effects on hamstring ROM and muscle length performance. ROM was measured by using sit-and-reach. Muscle length performance was measured using EMG to collect muscle activation, maximum voluntary contraction, evoked twitch force, and electromechanical delay. There were 17 subjects consisting of 7 men (22 +/- 1 years) and 10 women (23 +/- 5 years). All subjects are physically active on average 3 times/week and no previous experience using a roller-massager. The exclusion criteria was any history of neurological disease or musculoskeletal injuries in the previous years. The roller-massager was applied by using a constant pressure roller apparatus with a pace of 120 beats per minute. The roller was used from the popliteal fold to the gluteal fold on the biceps femoris. Measurements were taken 3 minutes after application. Muscle activation was measured with an EMG. The two electrodes were placed on the biceps femoris between the gluteal fold and popliteal fold about 2 cm apart on the muscle belly. MVC isometric force was measured with a Wheatstone bridge configuration strain gauge with the patient lying prone on a padded table and the contracting limb having a strap attached at the ankle joint. The action was performed by voluntary isometric knee flexion for a duration of four seconds with a minute of rest between the two reps. The sit-and-reach was performed by having the subjects take off their shoes and have one leg extended on the flexometer and the other bent with the dorsal foot at a 90 degree angle. Two measurements were take pre and post intervention. There was a significant 4.3% difference between the pre and post intervention measurements of ROM. There was no statistical difference for pre and post intervention measurements for EMD and maximum voluntary contraction force and activation. There was a significant difference between sets for the evoked twitch force.

Sylvain J, Reiman M. Differential Diagnosis and Management of an Older Runner with an Atypical Neurodynamic Presentation: A Case for Clinical Reasoning. Inter J Of Sports Phys Thera [serial online]. April 2015;10(2):234-245. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed August 25, 2016.

This was a case study about a 69 year old male runner who presented with left lower back pain and left buttock pain. Tensioning techniques were used as an intervention for 12 weeks. Patient showed an improvement in their symptoms and was able to return to running after 12 weeks of treatment.

Tham L, Lee H, Lu C. Cupping: From a biomechanical perspective. J of Biomechanics [serial online]. December 2006;39(12):2183-2193. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed August 25, 2016.

The purpose of this study is looking into cupping as Traditional Chinese Medicine in its uses compared to acupuncture. This paper explains how the pressure in the vacuum during the treatment has an affect on Qi which restores health balance. The research goes into depth on how the size of he cup and pressure has an affect on the healing effects of the treatment. Larger cups with more pressure causes more tension versus smaller cups or cups with less pressure. The paper describes how the vacuum impacts the capillary system underneath the skin. The capillary system has an impact on the healing process. This paper shows that cupping is a good Traditional Chinese Medicine for myofascial issues compared to acupuncture.

Vela LI, Denegar CR. The Disablement in the Physically Active Scale, Part II: The psychometric properties of an outcomes scale for musculoskeletal injuries. J Athl Train. 2010;45(6):630-641.

This article was about an observational study of the Disablement in the Physically Active Scale (DPAS) and its assessment of psychometric properties. It collected data from competitive and recreational athletes when they are healthy, after an acute injury, or after a persistent injury. They assessed the results with a Cronbach α and test-retest reliability. The results showed that the DPAS is a reliable, valid, and responsive tool for a patient outcome scale.

White KE. High hamstring tendinopathy in 3 female long distance runners. J of Chiro Med. 2011;10(2):93-99. doi:10.1016/j.jcm.2010.10.005.

This article is a case study of three female long distance runners with high hamstring tendinopathy. The runners were treated by a chiropractor who implemented Graston, eccentric hamstring exercises, proprioceptive training, and gluteus medius strengthening. The article showed how the Graston is a great tool to implement in the beginning of the rehab process to begin the healing process by increasing blood flow. It explains how the gluteus medius is a pelvis stabilizer and important in the lower kinectic chain. Proprioceptive was used to teach the body neuromuscular control. Eccentric exercises were used to increase flexibility and strengthen the musculotendinous junction. The combination of treatment creates a great rehabilitation plan for distance runners.

Wojtys, E., Huston, L., Taylor, P., & Bastian, S. (1996). Neuromuscular adaptations in isokinetic, isotonic, and agility training programs. / Adaptations neuromusculaires lors des programmes d'entrainement isocinetique, isotonique et d'agilite. AJMS, 24(2), 187-192.
The purpose of this study was to see if neuromuscular adaptations can be changed after isokinetic, isotonic, and agility training. 32 participants (16 women and 16 men) were placed into one of four groups (no training, isokinetic, isotonic, and agility training). Training groups did training for 30 minutes three times a week for six weeks. Isokinetic training involved knee flexion and extension and ankle dorsiflexion and plantarflexion on an isokinetic dynameter. Three sets of twelve were performed at 60 degrees. Isotonic training consisted of leg press, hamstring curls, and calf raises. They were performed for three sets of twelve. Agility training involved slideboarding, unilateral bounding, carioca, figure-8 runs, and backward runs. Testing was performed with anterior tibial translation testing, isokinetic peak torque, and endurance training. No significance among all groups for translation testing. Isokinetic group was significantly stronger in knee extension and ankle plantarflexion peak torque compared to all groups. There was no significance in endurance testing Agility had most improvement in time to peak muscle torque for knee extension and flexion. Agility training seems to produce the most desirable effects overall.

Youdas J, Hollman J, Hitchcock J, Hoyme G, Johnsen J. Comparison of Hamstring and Quadricepts Femoris Electromyographic Activity Between Men and Women During a Single-limb Squat on Both a Stable and Labile Surface. J Strength Cond Res (Allen Press Publishing Services Inc.) [serial online]. February 2007;21(1):105-111. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed August 25, 2016.

Study compared men and women muscle activation of hamstrings and quadriceps with EMG during single leg squat. They compared on stabile and labile surface. Women were significantly quadriceps dominant on both surfaces. Men were hamstring dominant on labile surface. Researchers believe that women are more prone at tearing ACLs due to being quadricep dominant which causes more of the femur and tibia versus the hamstring in the males. This study supports their hypothesis of women being quadriceps dominant and men being hamstring dominant.

VITA

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